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Electrical property enhancement by controlled percolation structure of carbon black in polymer-based nanocomposites *via* nanosecond pulsed electric field.

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Abstract

The research group of this study demonstrates how Nanosecond Pulsed Electric Fields can be used to tune the localization and formation of conducting carbon black (CB) assembles into linear structures with various thicknesses inside an insulating polymer matrix. The Electrorheology phenomenon of CB assembles in pre-polymer of polysiloxane under application of either DC or nanosecond pulsed electric field was observed utilizing optical microscopy method. Comparing to the typical DC electric field which has a value of 1875 V/mm, the nanosecond pulsed electric field facilities the increase in its electric field strength; generated between two constructed electrodes with a space size of 160 μm, to a value reaching 7500 V/mm. This type of electric field can overcome the voltage breakdown that occurs within the tested materials. The conduction structure of CB forms linear assemblies that anchor the composite film surfaces inside the matrix, which could be developed to much thicker percolation structures over five times by the application control of the nanosecond pulsed electric fields. Furthermore, the formation of vertically upright electrical percolation structures attributed to the remarkable decrease of the electrical resistivity of the resulting composites to 3 order of magnitude compared to the composites with a uniform distribution of filler. The electrorheology phenomenon under pulsed field was also tested by the optical observation method. The thickness as well as the concentration of CB particles were able to be controlled *via* the increasing in the nanosecond pulsed electric field. The novelty of this study lies in the utilizing of nanosecond pulsed field with a high electric strength that overcomes the electrical breakdown during tuning the carbonaceous filler assemblies. This unique technology is energy saving through fabricating polymer-based conductive materials without using surface modification or increasing the filler content.